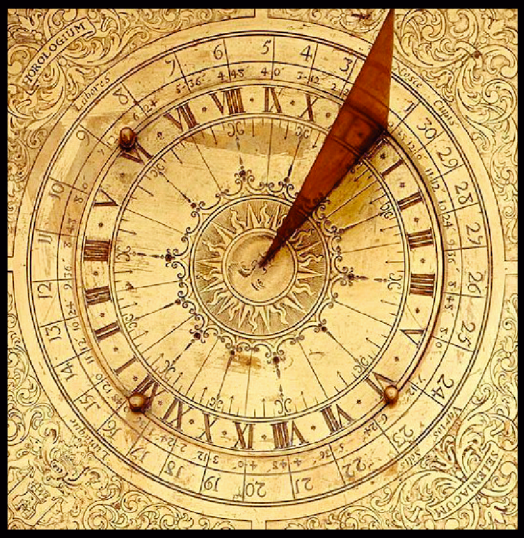
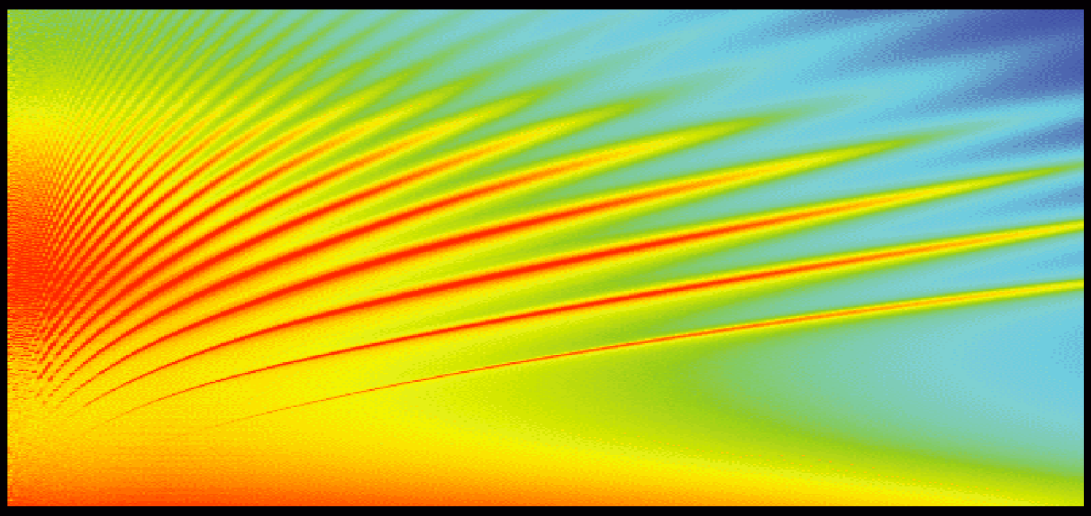
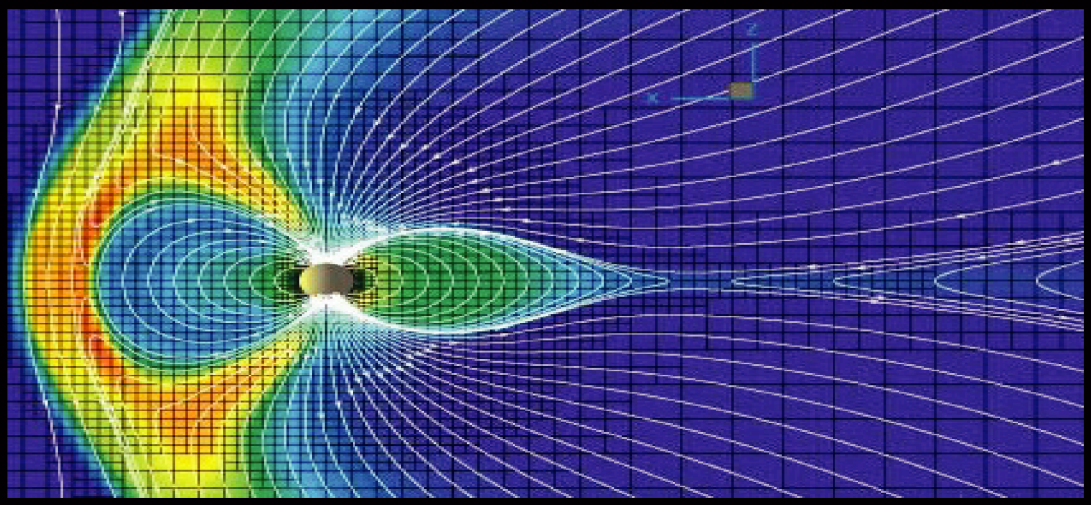
National Aeronautics and Space Administration







Space Math - I

This collection of activities is based on a weekly series of space science problems distributed to thousands of teachers during 2004-2005 school year. They were intended as extra-credit problems for students looking for additional challenges in the math and physical science curriculum in grades 7 through 9. The problems were designed to be authentic glimpses of modern engineering issues that come up in designing satellites to work in space, and to provide insight into the basic phenomena of the Sun-Earth system, specifically 'Space Weather'. The problems were designed to be 'one-pagers' with the student work sheet (with the top line for the student's name) and a Teacher's Guide and Answer Key as a second page. This compact form was deemed very popular by participating teachers.

This booklet was created by the NASA, IMAGE satellite program's Education and Public Outreach Project (POETRY).

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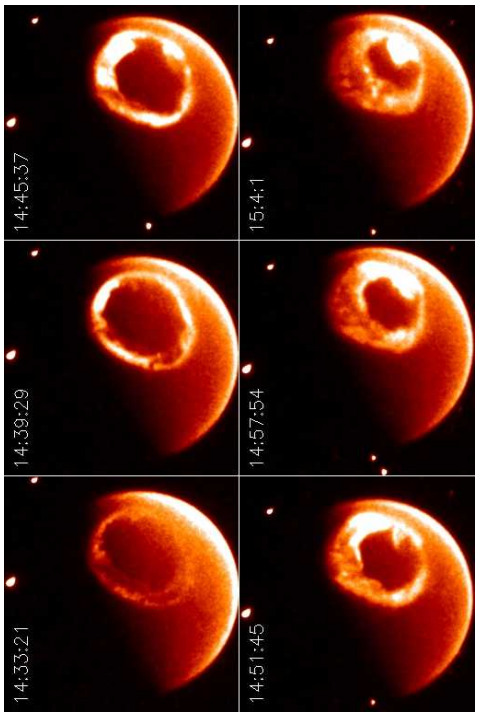

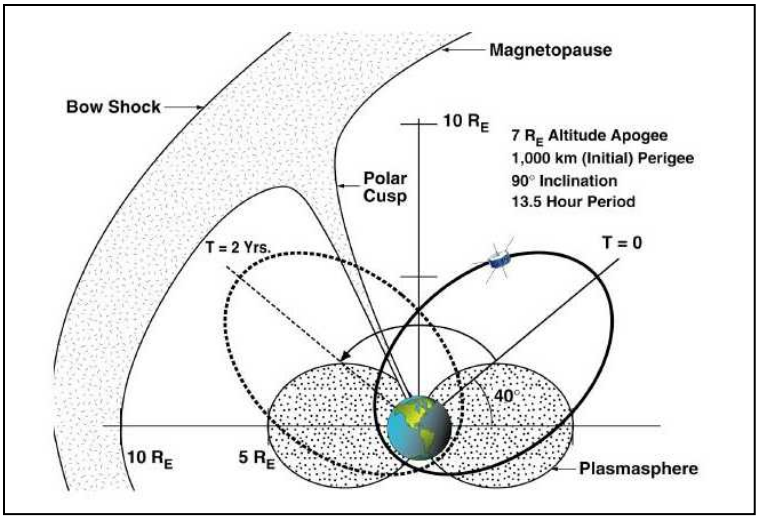

A series of images (left) of the Northern Lights from space taken by the IMAGE satellite. The satellite orbits Earth in an elliptical path (above), which takes it into many different regions of Earth's environment in space.

For more weekly classroom activities about the Sun-Earth system visit the IMAGE website,
http://image.gsfc.nasa.gov/poetry/weekly/weekly.html
Add your email address to our mailing list by contacting Dr. Sten Odenwald at
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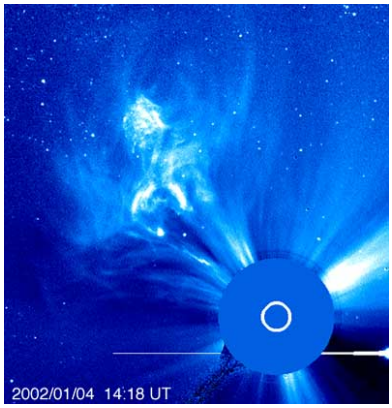
Table of Contents

Background

We live next to a very stormy star, the Sun, but you would hardly notice anything unusual most of the time. Its constant sunshine hides spectacular changes. Only the dazzling glow of the Northern Lights suggests that invisible forces are clashing in space. These forces may cause all kinds of problems for us, and our expensive technology. It doesn't take long for 'solar storms' to get here, either. X-rays from flares make the trip to Earth in just under 9 minutes, while the fastest moving plasma can make the journey in only 17 hours. Solar flares disrupt Earth's ionosphere and can cause satellite malfunctions, while the plasma clouds can change Earth's magnetic field. This leads to the displays of the aurora that humans have marveled at for thousands of years. Aurora light up the sky with billions of watts of power and cover millions of square kilometers. Why does all this happen? (*Photo- Auroral curtain by Jan Curtis)*

Space Weather



It has to do with Earth's magnetic field and how it is disturbed by solar storms and the solar wind. The wind carries its own magnetic field with it, and travels at speeds of millions of kilometers per hour. Scientists keep track of this interplanetary storminess using numbers that follow its ups and downs just like meteorologists follow a storm's speed, pressure and humidity. Periods of increased and decreased solar activity come and go every 11 years. Solar flares also have their own story to tell just like flashes of lightning in a bad storm. (*Photo - Coronal Mass Ejection seen by SOHO satellite)*

Models and Forecasting

Scientists have to keep track of many different kinds of phenomena in the universe, both big and small. That's why they have invented a way to write very big and very small numbers using 'scientific notation. They also have to master how to think in three-dimensions and how to use mathematical models. Once they find the right models, they can use them to make better predictions of when the next solar storm will arrive here at Earth, and what it will do when it gets here! *(Sketch of Earth's magnetic field)*

The following table connects the activities in this booklet to topics commonly covered in Grade 7, 8 and 9 pre-algebra and algebra textbooks. The specific national math and science education standards (NSF 'Project 2061') targeted by this product are:

Grade 6-8

Most of what goes on in the universe involves some form of energy being transformed into another form
Graphs can show a variety of possible relationships between two variables
A system can include processes as well as things
Locate information in reference books, and computer data bases
Understand writing that incorporates circle charts, bar graphs line graphs, tables, diagrams and symbols

Grade 9-12

Find answers to problems by substituting numerical values in simple algebraic formulas.
Use tables, charts and graphs in making arguments and claims in oral and written presentations.
Distances and angles inconvenient to measure directly can be found by using scale drawings.

Topic	Problem Number in the Book																			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Reading to be Informed	X	X	X				X	X			X		X	X				X	X	X
Scale drawings													X							
Triangle Properties											X									
Speed Distance, time												X			X					
Solving for X										X										
Equations and substitution																X	X	X	X	X
Calculating Areas of polygons							X													
Positive & negative numbers									X											
Decimal math.							X													
Time calculations	X	X												X	X					
Percentages				X										X						
Venn Diagrams				X																
Pie Charts					X															
Graph Analysis						X		X				X		X						
Open Inquiry						X														
Probability				X																

Useful Internet Resources

The human and technological impacts of solar storms and space weather:
http://www.solarstorms.org

Newspaper accounts of aurora and technology impacts from 1800-2001:
http://www.solarstorms.org/SRefHistory.html

Space weather and satellite failures
http://www.solarstorms.org/Ssatellites.html

NOAA space weather forecasting center
http://www.noaa.sec.gov/SWN

Space weather summaries and daily updates:
http://www.spaceweather.com

NASA Student Observation Network –Tracking a Solar Storm
http://son.nasa.gov/tass/index.htm

Archive of NASA TV programs about space weather for grades 6-10
http://www.solarstorms.org/STV.html

Movies and animations about space weather
http://www.solarstorms.org/SMovies.html

Frequently Asked Questions about space weather
http://www.solarstorms.org/SFAQs.html

Additional classroom activities
http://image.gsfc.nasa.gov/poetry/activities.html

Exploring Space Science Mathematics pre-algebra problem book
http://image.gsfc.nasa.gov/MathDocs/spacemath.html

Exploring Earth's Magnetic Field primer
http://image.gsfc.nasa.gov/poetry/magnetism/magnetism.html

IMAGE, Student's Guide to Sun-Earth Science topics
http://image.gsfc.nasa.gov/poetry/educator/students.html

The IMAGE, Soda Bottle Magnetometer
http://image.gsfc.nasa.gov/poetry/workbook/magnet.html

The Mysterious Van Allen Radiation Belts
http://radbelts.gsfc.nasa.gov/outreach/outreach.html

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